

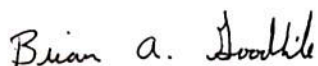
SEPTEMBER 7, 2017 | 14224 |

## Relative Accuracy Test Audit (RATA) of Three Combustion Turbines

Prepared for:

Marcus Hook Energy, LP  
Marcus Hook, Pennsylvania

The state and federal regulations applicable to this source have been reviewed and to the best of our knowledge, all testing requirements for this source have been included as part of this test program.



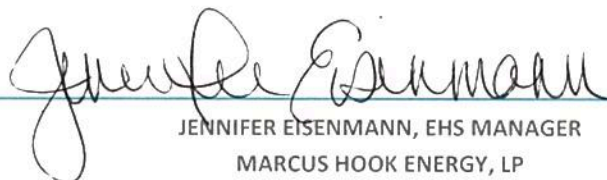
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BRIAN GOODHILE, SENIOR PROJECT SCIENTIST  
O'Brien & Gere Engineers, Inc.



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PATRICK GRADY, PROJECT ASSOCIATE  
O'Brien & Gere Engineers, Inc.

  
JENNIFER EISENMANN, EHS MANAGER  
MARCUS HOOK ENERGY, LP



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## 1. INTRODUCTION AND BACKGROUND

O'Brien & Gere (OBG) has been retained by Marcus Hook Energy, LP (Marcus Hook Energy) to conduct a Relative Accuracy Test Audit (RATA) on three continuous emissions monitoring systems (CEMS) serving three combustion gas turbines at the Marcus Hook Power and Steam Project located in Marcus Hook, Pennsylvania. The objective of the test program is to verify the relative accuracy (RA) of CEMS as outlined in the facility's Operating Permit Application (PA-23-00089). The testing is scheduled to be conducted the week of October 2, 2017.

All Performance testing will be carried out in accordance with the procedures in 40 CFR 60, Appendix B, Performance Specifications (PS); 40 CFR 75 Appendix A and B; and Pennsylvania Department of Environmental Protection (PADEP) Continuous Source Monitoring Manual Revision No. 8 (CSMM8). OBG will be responsible for the RATA testing and the preparation of the final test report. Plant personnel will be responsible for monitoring process operations and providing necessary data.

The following test protocol has been prepared on behalf of Marcus Hook Energy and is submitted for review and approval.

The following sections of this protocol provide a source description and summary of process conditions, summary of test methods to be used, final reporting format, and details on quality assurance and quality control (QA/QC) procedures.

### 1.1 EMISSIONS TESTING PROGRAM PARTICIPANTS

#### Facility

Name: Marcus Hook Energy, LP  
 Address: 100 Green Street  
 Marcus Hook, PA 19061  
 Contact: Jennifer Eisenmann  
 Email: [jennifer.Eisenmann@ge.com](mailto:jennifer.Eisenmann@ge.com)  
 Telephone number: (610) 364-2470

#### Source Testing Firm

**PADEP Environmental Laboratory Registration No. 46-03650**

Name: O'Brien & Gere Engineers, Inc.  
 Address: 301 E. Germantown Pike,  
 Bentwood Campus  
 3<sup>rd</sup> Floor  
 E. Norriton, PA 19401  
 Contact: Brian A. Goodhile  
 Email: [Brian.Goodhile@obg.com](mailto:Brian.Goodhile@obg.com)  
 Telephone number: (215) 628-9100



## 2. SOURCE DESCRIPTION

This section provides a description of the process to be tested, as well as operating requirements and parameters to be maintained during testing.

### 2.1 PROCESS DESCRIPTION

The Facility is located at 100 Green Street in Marcus Hook, Pennsylvania. The Facility houses three combined cycle units that consist of three General Electric Model 7FA combustion turbine generators (CTGs) each served by a heat recovery steam generator (HRSGs) with supplemental duct firing. One steam turbine generator (STG) is common to all three power trains. The CTGs are restricted to combusting pipeline natural gas only and are nominally rated at about 183 megawatts (MW) each with a maximum heat input rate of about 1,949 MMBtu/hr, HHV. The duct burners fire pipeline natural gas and/or gas supplied by the neighboring Sunoco Logistics facility and have a maximum heat input rate of 333 MMBtu/hr. The maximum energy input of each combined cycle unit is about 2,282 MMBtu, HHV. The STG has a nominal generating capacity of 231 MW. Nitrogen oxide (NO<sub>x</sub>) emissions from the CTG and duct burners at each unit are controlled by a selective catalytic reduction (SCR) system.

The CTGs are subject to 40 CFR 60 Subpart GG. The CTG/HRSG trains are also subject to the Pennsylvania Department of Environmental Protection (PADEP) air permit which restricts the emissions of NO<sub>x</sub> and CO with emission limits that are monitored by CEMS. For this reason, among others, periodic quality assurance testing programs for NO<sub>x</sub>, CO, and O<sub>2</sub> are required to be conducted (e.g. annual relative accuracy test audits) according

to 40 CFR 75 Appendix A and B, 40 CFR 60 Appendix B and F and PADEP Continuous Source Monitoring Manual Revision 8 (PADEP CSMM8).

### 2.2 SAMPLE LOCATION DESCRIPTION

Each unit has its own stack for exhausting emissions to the atmosphere. The stacks serving each CTG measure 20 feet (ft) (240 inches) in diameter at the test ports which are approximately 140 ft above grade level with an exit elevation of approximately 275 ft above grade level. The test ports are located approximately 37.2 ft (1.86 stack diameters) downstream and approximately 135 ft (6.75 stack diameters) upstream from the nearest disturbances.

Schematics of the test locations are presented in Appendix A.

### 2.3 CEMS DESCRIPTION

A single, dedicated continuous emissions monitoring system (CEMS) is installed at each CTG. The CEMS configuration includes: a dual range Thermo Fisher 42i-LS NO<sub>x</sub> analyzer with a 0-10 ppm low range and a 0-200 ppm high range, diluent Servomex 1440DSTD oxygen (O<sub>2</sub>) monitor with a 0-25% range, and a dual range ThermoFisher 48i carbon monoxide (CO) analyzer with a 0-20 low range and a 0-2000 ppm high range for measurements at the outlet stacks; and a data acquisition and handling system.

Table 2.1 below summarizes CTGs CEMS information.

**Table 2.1 Summary of CTGs CEMS.**

Unit	Parameter	Analyzer Manufacturer	Analyzer Model	Instrument Ranges
CTG	NO <sub>x</sub>	Thermo Fisher	42i-LS	0 – 10, 0-200 ppm
	O <sub>2</sub>	Servomex	1440D	0-25%
	CO	Thermo Fisher	48i	0-20, 0-2000 ppm

### 2.4 UNIT OPERATING PARAMETERS

The RATAs will be performed while the units are operating above 50 percent of the maximum operating load, as required under 40 CFR Part 60 and/or at the normal or alternative normal operating load as required under 40 CFR Part 75. The results from a recent 40 CFR Part 75 load level analysis are shown in Appendix D illustrating the load levels that CTGs will be operated during the

upcoming RATAs. Unit operating data and CEMS outputs (1-minute averages) will be collected by facility personnel during the RATA testing. Operating data will include total load (MW), fuel flow (kscfh), total heat input (Btu/hr), and if applicable gas supplied by the neighboring Sunoco Logistics facility fuel factor (scf/MMBtu). This data will be provided to OBG and included in the final test report.





### 3. SUMMARY OF TEST PROGRAM

The RATAs will be used to verify the ability of a CEMS to accurately measure and report a given pollutant concentration or emissions rate from an affected source and to determine any 40 CFR 75 NO<sub>x</sub> lb/MMBtu bias in those measurements. The RATA will be carried out in accordance with the procedures in 40 CFR 60, Appendix B, Performance Specifications (PS); 40 CFR 75 Appendix A and B; and Pennsylvania Department of Environmental Protection (PADEP) Continuous Source Monitoring Manual Revision No. 8 (CSMM8).

The RATAs will be performed while the units are operating above 50 percent of the maximum operating load, as required under 40 CFR Part 60 and/or at the normal or alternative normal operating load as required under 40 CFR Part 75. Passing RATA results will be determined by comparing the results from the CEMS to concurrent measurements from reference method (RM) analyzers over a prescribed series of test runs (i.e., minimum of nine).

Units of comparison for each CTG/HRSR for each pollutant will include: NO<sub>x</sub> (ppmvd, ppmvd @15% O<sub>2</sub>, lb/hr, and lb/MMBtu), CO (ppmvd, ppmvd @15% O<sub>2</sub>, and lb/hr), and O<sub>2</sub> (%). RM values will be compared with the on-site CEMS to document performance as required in the PADEP CSMM8, 40 CFR 60 and 40 CFR 75. All relative accuracies will be established on-site and will be governed by the following sets of rules.

In accordance with PADEP CSMM8, Table II, the NO<sub>x</sub> RATA results will be acceptable if the relative accuracy (RA) does not exceed 20.0 percent of the reference method, expressed as the sum of the absolute value of the mean and the absolute value of the 95 percent confidence coefficient; if the alternative relative accuracy (ARA) does not exceed 10.0 percent of the lowest standard (permit limit); if the average difference between the CEMS and RM values does not exceed 5.0 parts per million (ppm), if the average difference between the CEMS and RM values does not exceed 5.0 lbs/hr, or if the average difference between the CEMS and RM values does not exceed 0.02 lb/MMBtu.

In accordance with PADEP CSMM8 Table III, the O<sub>2</sub> RATA results are acceptable if the RA does not

exceed 20.0 percent of the reference method, expressed as the sum of the absolute value of the mean and the absolute value of the 95 percent confidence coefficient; or if the average difference between the CEMS and RM values does not exceed 1.0 percent absolute.

In accordance with PADEP CSMM8, Table IV, the CO RATA results will be acceptable if the RA does not exceed 10.0 percent of the reference method, expressed as the sum of the absolute value of the mean and the absolute value of the 95 percent confidence coefficient; if the ARA does not exceed 5.0 percent of the lowest standard (permit limit); if the average difference between the CEMS and RM values does not exceed 5.0 ppm; if the average difference between the CEMS and RM values does not exceed 5.0 lb/hr, or if the average difference between the CEMS and RM values does not exceed 0.02 lb/MMBtu.

In accordance with 40 CFR 60, Appendix B, PS 2, Section 13.2, the NO<sub>x</sub> RATA results will be acceptable if the RA does not exceed 20.0 percent of the RM when average emissions during the test are greater than 50 percent of the emission standard or ARA does not exceed 10.0 percent of the emission standard when the average emissions during the test are less than 50 percent of the emission standard. Part 60, Appendix B, PS 2, Section 8.4.1 further requires that the unit be operating at greater than 50 percent of normal load.

In accordance with 40 CFR 75, Appendix A, Section 3.3.2(a) and (b), the NO<sub>x</sub> RATA results will be acceptable if the RA does not exceed 10.0 percent or if during the RATA the average NO<sub>x</sub> emission rate is less than or equal to 0.200 lb/MMBtu and the average difference between the CEMS and RM values does not exceed 0.020 lb/MMBtu. Passing this set of criteria requires the CEMS to be retested after no more than two operating quarters. Alternatively, in accordance with 40 CFR 75, Appendix B, Section 2.3.1.2(a) and (f), and Appendix B, Figure 2, the NO<sub>x</sub> RATA results will be acceptable if the RA does not exceed 7.5 percent or if during the RATA the average NO<sub>x</sub> emission rate is less than or equal to 0.200 lb/MMBtu and the average difference between the CEMS and RM values does not exceed 0.015 lb/MMBtu. Passing this set of



criteria allows the CEMS to be retested after four operating quarters or at least within eight calendar quarters.

Relative accuracy testing will be performed on each CEMS for NO<sub>x</sub>, CO, and O<sub>2</sub>. The test for each CTG/HRSG CEMS will include at least nine twenty-one minute runs.

The stratification tests for the CTGs will follow the requirements of 40 CFR 75. Pending a successful test under the guidelines of 40 CFR 75 Appendix A, Section 6.5.6.3(a) RATA testing will be from the most representative short reference method measurement line (0.4, 1.2, 2.0 meters).

The applicable calibration records for each fuel flow meter will be included in the final report as required by the PADEP CSMM8.

The NO<sub>x</sub>, CO and O<sub>2</sub> RATA testing will be performed in accordance with the Pennsylvania Department of Environmental Protection (PADEP) Continuous Source Monitoring Manual (Revision No. 8, December 2006) and the PADEP Source Testing Manual (Revision No. 3.3, November 2000).

## 4. SAMPLING AND ANALYTICAL PROCEDURES

This section provides a description of the test methods that will be utilized during the RATA program.

### 4.1 PROPOSED TEST METHODS

The RATA test procedures will be conducted in accordance with the most recent updates to the United States Environmental Protection Agency (USEPA) Reference Methods (RM) described in 40 CFR 60; Appendix A.

Method 1:	Sample and velocity traverses for stationary sources
Method 3A:	Determination of oxygen and carbon dioxide concentrations in emissions from stationary sources – Instrumental Analyzer Procedure
Method 7E:	Determination of nitrogen oxides emissions from stationary sources – Instrumental Analyzer Procedure
Method 10:	Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)
Method 19:	Determination of SO <sub>2</sub> removal efficiency and PM, SO <sub>2</sub> , NO <sub>x</sub> emission rates from Electric Utility Steam Generators F-factor determination

### 4.2 TESTING PROCEDURE

Concentrations of oxygen (O<sub>2</sub>) will be evaluated in accordance with USEPA RM 3A using a California Analytical Model 600 or equivalent paramagnetic analyzer. Concentrations of Nitrogen Oxide (NO<sub>x</sub>) will be evaluated in accordance with USEPA RM 7E using a TECO Model 42I or equivalent chemi-luminescent analyzer. Concentrations of Carbon Monoxide (CO) will be evaluated in accordance with USEPA RM 10 using a TECO Model 48I or equivalent non-dispersive infrared analyzer.

A continuous gas sample will be extracted from the exhaust duct through a sintered filter, stainless steel probe, and heated Teflon line and through a conditioning system used to remove moisture from the gas stream. All material that comes in contact with the sample will be constructed of stainless steel, glass, or Teflon.

Analyzer outputs are monitored using a laptop computer and PCMCIA card and recorded by a data acquisition system (DAS). The DAS will report emissions data as 1-minute averages for each test run. Pollutant emissions data reported by the DAS will be corrected for system zero and span bias.

Table 4.1 outlines anticipated analyzer ranges and calibration gases to be used during the test program. OBG will be prepared to use alternate ranges should pollutant concentrations dictate.

**Table 4.1 Analyzer Operating Range and Calibration Gases.**

Analyzer ID	Source ID	Calibration Span	Calibration Gases <sup>a</sup>
O <sub>2</sub> (CAI 600)	CTGs	0 – 21%	~12.2 % O <sub>2</sub> in N <sub>2</sub> ~21.0 % O <sub>2</sub> in N <sub>2</sub>
NO <sub>x</sub> (TECO 42I)	CTGs	0 – 12 ppm	~6 ppm NO in N <sub>2</sub> ~12 ppm NO in N <sub>2</sub>
CO (TECO 48I)	CTGs	0 – 12 ppm	~6 ppm CO in N <sub>2</sub> ~12 ppm CO in N <sub>2</sub>

<sup>a</sup> Analyzers will be zeroed with ultra high purity (UHP) grade nitrogen meeting USEPA Part 72.2 criteria.

Example field data sheets for the above referenced methods are included in Appendix B. Example

calculations for the RATA test program are presented in Appendix C.

### 5. REPORTING

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A RATA report will be submitted to Pennsylvania Department of Environmental Protection within 60 days following completion of field activities. The test report is anticipated to be structured as follows:

- Introduction and purpose
- Source descriptions
- Process operating data
- Sampling and analytical procedures
- Results, discussion and conclusions from RATA testing

Appendices including process operating data, raw field data sheets, equipment calibration data, calibration gas certificates, sampling parameters and supporting calculations.



## 6. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC will be based on the recommended QA/QC procedures of the various sampling and analytical methods that will be used for the RATA. This section summarizes the pertinent QA/QC procedures that will be employed during the emissions testing program.

### 6.1 EQUIPMENT CALIBRATION

Analyzers will be calibrated in accordance with the procedures outlined in the corresponding USEPA test methods and/or the USEPA document entitled Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III - Stationary Source Specific Methods (EPA 600/R-94/038c).

At the beginning of and following every test run each analyzer and the entire instrument measurement system will be challenged with USEPA Protocol No. 1 gas standards (zero and mid gas) in accordance with procedures specified in each respective test method. The calibration gases will be introduced to the sampling system near the end of the sample probe to expose the calibration standards to as much of the system as possible.  $\text{NO}_x$ , CO and  $\text{O}_2$  concentrations will be bias corrected in accordance with USEPA RM 7E procedures.

A nitrogen dioxide ( $\text{NO}_2$ ) to nitrogen oxide (NO) converter efficiency test will be conducted daily prior to the start of the RATA test program in accordance

with USEPA RM 7E procedures utilizing an EPA Protocol No. 1 gas standard.

Protocol calibration standards will be prepared in accordance with USEPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. The accuracy of these gases will be  $\pm 2\%$  or better. Copies of the calibration certificates will be included in the final source test report.

### 6.2 AIR EMISSION TESTING BODY

In accordance with 40 CFR 75.21 (f) the RATA will conform to the requirements set forth in 40 CFR 75 Appendix A; Section 6.1.2. At a minimum, one Qualified Individual, as defined in 40 CFR 75.2 and ASTM D7036-04, will be on-site to supervise/perform all reference method testing. Copies of the Qualified Individual Exam certificates accompanied with a letter of certification for the relevant test methods signed by a member of the senior management staff will be included in the final source test report.

### 6.3 TEST DATA AND REPORT REVIEW

Test data input and emission calculations will be double-checked for accuracy. The test results will be reviewed by senior personnel for completeness and accuracy. The final report is peer reviewed by senior personnel and certified by the project manager.